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(54) **Semiconductive resin composition.**

(57) A semiconductive resin composition comprising 100 parts by weight of a polymer component comprising an ethylene-based copolymer, an ethylene-propylene rubber, and a low molecular weight polyethylene having an average molecular weight of 1,000 to 4,000, and 40 parts by weight or more of electroconductive carbon black.

**SEMICONDUCTIVE RESIN COMPOSITION**FIELD OF THE INVENTION

This invention relates to a semiconductive resin composition suitable for forming internal- or external-  
 5 semiconductive layers of high voltage power cables having polyethylene or crosslinked polyethylene as insulator, and, especially, to a semiconductive resin composition which can provide improved water tree resistance.

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BACKGROUND OF THE INVENTION

High voltage power cables using polyethylene or crosslinked polyethylene as insulator are provided with an internal semiconductive layer surrounding the outer periphery of the conductor and an external  
 15 semiconductive layer surrounding the outer periphery of the insulator. Internal semiconductive layers relax heterogeneous electrical stress attributed to irregularities in the twisted wires in conductors, and also increase adhesion between the conductor and the insulator. External semiconductive layers homogenize electrical stress on the insulator surface.

Generally, for forming the semiconductive layers ethylene-based copolymer used as base polymer,  
 20 such as ethylene-vinyl acetate copolymer and ethylene-ethyl acrylate copolymer, mixed with conductive carbon black are used.

When the conductive carbon black is not sufficiently dispersed in the base polymer, coarse grains are formed by coagulation of the carbon black particles. When the grains are formed in the interface between the insulator and the semiconductor layers, water tree deterioration initiates from these grains.

25 JP-A-59-8216 discloses a method of improving the water tree resistance by blending ethylene-propylene rubber with an ethylene-based copolymer, to prevent the formation of grains. (The term "JP-A" as used herein means an "unexamined published Japanese patent application".) According to this method, a large shearing stress is generated at the time of dispersing the conductive carbons in the polymer by using kneaders such as Bambury mixer so that the grains are finely divided to become harmless.

30 The above composition is, however, so viscous that a commonly used manufacturing method for high voltage cables, i.e., the common extruding method cannot be applied. In the common extruding method, the semiconductive layer and the insulator layer are simultaneously extruded on the outer surface of the conductor using a common crosshead. This method avoids disconformity between the semiconductor and the insulating layers. Since the common crosshead is used for the both layers, the extruding temperature of  
 35 the semiconductive layer is restricted to be the same as that of the insulator layer or lower. When crosslinked polyethylene insulator is used, the temperature is limited to 130 °C or less. In that case of the above composition comprising an ethylene-based copolymer blended with an ethylene-propylene rubber, the viscosity is extremely high so that extrusion becomes very difficult.

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SUMMARY OF THE INVENTION

The present invention was made to solve the above problems. Therefore it is an object of the present  
 45 invention to provide a semiconductive resin composition having excellent extrusion workability which suppress water tree formation.

A semiconductive resin composition according to the present invention comprises 100 parts by weight of a polymer comprising an ethylene-based copolymer, an ethylene-propylene rubber, and a low molecular weight polyethylene having an average molecular weight of 1,000 to 4,000, and 40 parts by weight or more  
 50 of conductive carbon black.

DETAILED DESCRIPTION OF THE INVENTION

Ethylene-based copolymers suitably used in the present invention include ethylene-vinyl acetate copolymers, ethylene-ethyl acrylate copolymer, and ethylene-methyl methacrylate copolymer.

Either ethylene-propylene copolymers or ethylene-propylene-unconjugated diene terpolymers are useful ethylene-propylene rubbers.

5 A chief feature of the present invention resides in that a low molecular weight polyethylene having an average molecular weight between 1,000 and 4,000 is blended as a third component in addition to an ethylene-based copolymer and an ethylene-propylene rubber. By this viscosity is lowered to enable common extrusion while maintaining water tree resistance.

The low molecular weight polyethylene to be used is a waxy material having a softening point between 10 100 and 130 °C. Waxy materials such as paraffin wax or microcrystalline wax having softening or melting points lower than the above temperature range melt in the initial steps of kneading with carbon black, so that no high shearing stress can be obtained. Therefore, though viscosity is lowered, the grains are not reduced and the water tree resistance cannot be maintained. A low molecular weight propylene, which has a high softening point, does not melt at the common extrusion temperature and generates sufficiently high 15 shearing stress to greatly reduce the amount of the grains, but extrusion operation becomes impossible due to the high viscosity. Further, stearic acid amides or zinc stearates having softening or melting points between 100 and 130 °C, but with low molecular weights, are prone to move to the surface of the semiconductor layer. Also, they act as external lubricants between the processing machine and the material to avoid the sticking. Therefore, they are unsuitable for lowering the viscosity.

20 Preferably, the composition should be, from 40 to 90% of ethylene copolymer, from 5 to 30 wt% of an ethylene-propylene rubber, and from 5 to 30 wt% of a low molecular weight polyethylene. When the ethylene-propylene rubber content is too low, the grain formation and water trees are not effectively suppressed, whereas too high a content makes the common extrusion unoperable due to the increased viscosity. The content of the low molecular weight polyethylene varies depending on the content of the 25 ethylene-propylene rubber. Too low a content is insufficient to effectively lower the viscosity, and too high a content fails to suppress the grain formation.

Carbon blacks used in the present invention include those of common types used as conductivity imparting agent, such as furnace black, acetylene black, and Ketjen black. These can be used alone or in combinations of two or more thereof. Most effective among them in decreasing the grain formation is the 30 furnace carbon black with arithmetic mean particle size of 25 to 40  $\mu$ m, iodine adsorption of 40 to 60 mg/g, DBP oil absorption (by JIS A method) of 120 to 150 ml/100g. The arithmetic mean particle size is that obtained by electron microscopic observation. Particles smaller than 25  $\mu$ m increases viscosity so that extrusion workability is decreased, and particles having the particle size exceeding 40  $\mu$ m tend to give insufficient conductivity. In addition, a composition with iodine adsorption of less than 40 mg/g is deficient in 35 conductivity, whereas that exceeding 60 mg/g is deteriorated in extrusion workability due to a too high viscosity. DBP oil absorption is measured by JIS A method. When it is lower than 120 ml/100 g, conductivity obtained is not high enough and a value higher than 150 ml/100 g increases the viscosity of the composition and adversely affects the extrusion workability. Acetylene black may be used together with above furnace black so far as the viscosity of the composition is not considerably increased.

40 The addition of the conductive carbon black should be 40 parts by weight or higher per 100 parts by weight of the polymer component. If the addition is lower than this lower limit, conductivity obtained is not high enough.

Lubricants, antioxidants, and inhibitors against metallic damage and deterioration, may be added to the composition of the present invention. Preferable lubricants are those acting as external lubricants which 45 prevents adhesion of the composition to the processing machine. Examples of such lubricants are aliphatic alcohols, esters of fatty acids, metal salts of fatty acids, and fatty acid amides. They can be used independently or in combinations of two or more. Examples of antioxidants include thiobisphenols, alkylidenebisphenols, alkylphenol, hydroxybenzyl compounds, aminophenols, hydroxyphenyl propionates, sec-aromatic amines, thioethers, phosphites, phosphonites. They may be used independently or in combinations of two or more thereof. 50

The composition of the present invention may be crosslinkable or noncrosslinkable. In the case of the former, generally used as the crosslinking agents are organic peroxides. Examples of such agents include dialkyl peroxides, such as dicumyl peroxides, 1,3-bis(tert-butylperoxyisopropyl)benzene, 2,2-dimethyl-2,5-di-(tert-butylperoxy)hexane-3.

55 The present invention is now illustrated in greater detail with reference to nonlimiting Examples and Comparative Examples. In these examples, all percents and parts are by weight unless otherwise indicated.

EXAMPLES

The components were kneaded with a Bambury mixer to give the compositions of Examples 1 to 13 and Comparative Examples 1 to 8 shown below. Each compound thus obtained was fed to an extruder to form internal and external semiconductive layers together with polyethylene insulator on a copper twisted wire conductor having across sectional area of 150 mm<sup>2</sup> by extrusion coating using common head. The thickness of the layers were 1 mm each for the internal and the external semiconductive layers and 4 mm for the polyethylene insulator layer. The extrusion temperature for both the internal and external semiconductive layers were 120 °C. After extrusion, crosslinking was effected by heating to give a crosslinked polyethylene insulated power cables. The insulating layer was prepared by mixing 100 parts of a low density polyethylene (with density of 0.920 g/cm<sup>3</sup> and melt index of 1.0 g/10 min.) with 2.5 parts of dicumyl peroxide as the crosslinking agent and 0.25 parts of 4,4'-thio-bis(3-methyl-6-tert-butylphenol) as the anti-oxidant.

EXAMPLE 1

Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	90 parts
Ethylene-propylene rubber (with Mooney viscosity of ML <sub>1+4</sub> = 40)	5 parts
Low molecular weight polyethylene (average molecular weight of 1,500; softening point of 105 °C)	5 parts
4,4'-Thio-bis(3-methyl-6-tert-butyl-phenol)	0.5 parts
1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
Acetylene black	65 parts

EXAMPLE 2

Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	85 parts
Ethylene-propylene rubber (with Mooney viscosity of ML <sub>1+4</sub> = 40)	10 parts
Low molecular weight polyethylene (average molecular weight of 1,500; softening point of 105 °C)	5 parts
4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
Acetylene black	65 parts

EXAMPLE 3

Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	75 parts
Ethylene-propylene rubber (with Mooney viscosity of $ML_{1+4} = 40$ )	10 parts
Low molecular weight polyethylene (average molecular weight of 1,500; softening point of $105^{\circ}\text{C}$ )	15 parts
4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
Acetylene black	65 parts

EXAMPLE 4

Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	60 parts
Ethylene-propylene rubber (with Mooney viscosity of $ML_{1+4} = 40$ )	20 parts
Low molecular weight polyethylene (average molecular weight of 2,000; softening point of $107^{\circ}\text{C}$ )	20 parts
4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
Acetylene black	65 parts

EXAMPLE 5

Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	40 parts
Ethylene-propylene rubber (with Mooney viscosity of $ML_{1+4} = 40$ )	30 parts
Low molecular weight polyethylene (average molecular weight of 1,500; softening point of $105^{\circ}\text{C}$ )	30 parts
4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
Acetylene black	65 parts

EXAMPLE 6

Ethylene-ethyl acrylate copolymer (containing 17% of ethyl acrylate; with melt index of 18)	80 parts
Ethylene-propylene rubber (with Mooney viscosity of $ML_{1+4} = 40$ )	10 parts
Low molecular weight polyethylene (average molecular weight of 4,000; softening point of $126^{\circ}\text{C}$ )	10 parts
4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
Acetylene black	65 parts

EXAMPLE 7

Ethylene-ethyl acrylate copolymer (containing 17% of ethyl acrylate; with melt index of 18)	60 parts
Ethylene-propylene rubber (with Mooney viscosity of $ML_{1+4} = 40$ )	20 parts
Low molecular weight polyethylene (average molecular weight of 4,000; softening point of $126^{\circ}\text{C}$ )	20 parts
4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
Acetylene black	65 parts

EXAMPLE 8

Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	90 parts
Ethylene-propylene rubber (with Mooney viscosity of $ML_{1+4} = 40$ )	5 parts
Low molecular weight polyethylene (average molecular weight of 1,500; softening point of $105^{\circ}\text{C}$ )	5 parts
4,4'-Thio-bis(3-methyl-6-tert-butyl-phenol)	0.5 parts
1,3-Bis(tert-butylperoxy-isopropyl)benzene	0.5 parts
Furnace carbon black (with arithmetic mean particle size of 30 $\mu\text{m}$ ; iodine adsorption of 53 mg/g; DBP oil absorption of 133 $\text{mL}/100\text{ g}$ )	75 parts

EXAMPLE 9

5	Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	85 parts
	Ethylene-propylene rubber (with Mooney viscosity of $ML_1 + 4 = 40$ )	10 parts
	Low molecular weight polyethylene (average molecular weight of 1,500; softening point of $105^\circ\text{C}$ )	5 parts
	4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
	1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
10	Furnace carbon black (with arithmetic mean particle size of $30\text{ }\mu\text{m}$ ; iodine adsorption of $53\text{ mg/g}$ ; DBP oil absorption of $133\text{ ml/100 g}$ )	75 parts

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EXAMPLE 10

20	Ethylene-ethyl acrylate copolymer (containing 17% of ethyl acrylate; with melt index of 18)	60 parts
	Ethylene-propylene rubber (with Mooney viscosity of $ML_1 + 4 = 40$ )	20 parts
25	Low molecular weight polyethylene (average molecular weight of 4,000; softening point of $126^\circ\text{C}$ )	20 parts
	4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
30	1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
	Furnace carbon black (with arithmetic mean particle size of $30\text{ }\mu\text{m}$ ; iodine adsorption of $53\text{ mg/g}$ ; DBP oil absorption of $133\text{ ml/100 g}$ )	75 parts

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EXAMPLE 11

40	Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	85 parts
	Ethylene-propylene rubber (with Mooney viscosity of $ML_1 + 4 = 40$ )	10 parts
45	Low molecular weight polyethylene (average molecular weight of 1,500; softening point of $105^\circ\text{C}$ )	5 parts
	4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
50	1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
	Furnace carbon black (with arithmetic mean particle size of $22\text{ }\mu\text{m}$ ; iodine adsorption of $104\text{ mg/g}$ ; DBP oil absorption of $129\text{ ml/100 g}$ )	75 parts

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EXAMPLE 12

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Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	85 parts
Ethylene-propylene rubber (with Mooney viscosity of $ML_1 + 4 = 40$ )	10 parts
Low molecular weight polyethylene (average molecular weight of 1,500; softening point of 105° C)	5 parts
4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
Furnace carbon black (with arithmetic mean particle size of 43 $\mu$ ; iodine adsorption of 44 mg/g; DBP oil absorption of 115 ml/100 g)	75 parts

EXAMPLE 13

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Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	85 parts
Ethylene-propylene rubber (with Mooney viscosity of $ML_1 + 4 = 40$ )	10 parts
Low molecular weight polyethylene (average molecular weight of 1,500; softening point of 105° C)	5 parts
4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
Furnace carbon black (with arithmetic mean particle size of 34 $\mu$ ; iodine adsorption of 51 mg/g; DBP oil absorption of 103 ml/100 g)	75 parts

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COMPARATIVE EXAMPLE 1

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Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	100 parts
4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
Acetylene black	65 parts

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COMPARATIVE EXAMPLE 2

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Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	85 parts
Ethylene-propylene rubber (with Mooney viscosity of $ML_1 + 4 = 40$ )	15 parts
4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
Acetylene black	65 parts



COMPARATIVE EXAMPLE 3

5	Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	85 parts
	Ethylene-propylene rubber (with Mooney viscosity of $ML_{1+4} = 40$ )	10 parts
10	Low molecular weight polyethylene (average molecular weight of 5,000; softening point of 111 °C)	5 parts
	4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
15	1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
	Acetylene black	65 parts

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COMPARATIVE EXAMPLE 4

25	Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	80 parts
	Ethylene-propylene rubber (with Mooney viscosity of $ML_{1+4} = 40$ )	10 parts
	Paraffin wax (melting point of 66 °C)	10 parts
	4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
30	1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
	Acetylene black	65 parts

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COMPARATIVE EXAMPLE 5

40	Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	80 parts
	Ethylene-propylene rubber (with Mooney viscosity of $ML_{1+4} = 40$ )	10 parts
	Microcrystalline Wax (melting point of 90 °C)	10 parts
	4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
	1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
45	Acetylene black	65 parts

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COMPARATIVE EXAMPLE 6

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Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	88 parts
Ethylene-propylene rubber (with Mooney viscosity of $ML_1 + 4 = 40$ )	10 parts
Zinc stearate (melting point of $120^\circ \text{C}$ )	10 parts
4,4'-Thio-bis(3-methyl-6-tert-butyl-phenol)	2 parts
1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
Acetylene black	65 parts

## COMPARATIVE EXAMPLE 7

Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	80 parts
Ethylene-propylene rubber (with Mooney viscosity of $ML_1 + 4 = 40$ )	10 parts
Low molecular weight polyethylene (softening point of $145^\circ \text{C}$ )	10 parts
4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
Acetylene black	65 parts

## COMPARATIVE EXAMPLE 8

Ethylene-vinyl acetate copolymer (containing 14% of vinyl acetate; with melt index of 15)	85 parts
Ethylene-propylene rubber (with Mooney viscosity of $ML_1 + 4 = 40$ )	10 parts
Low molecular weight polyethylene (average molecular weight of 1,500; softening point of $105^\circ \text{C}$ )	5 parts
4,4'-Thio-bis(3-methyl-6-tert-butylphenol)	0.5 parts
1,3-Bis(tert-butylperoxyisopropyl)benzene	0.5 parts
Acetylene black	35 parts

The compositions given above and the cables prepared by using them were evaluated and the results are given in Table 1 below.

Evaluations were made according to the following. Extrusion workability: the state of cable at extrusion was observed, i.e., it was decided whether common extrusion was applicable or not.

Grain (particle generation): a compound kneaded with a Bambury mixer was extruded into a 1 mm thick and 30 mm wide tape using an extruder with a barrel diameter of 30 mm, and the surface of the tape was visually observed. Water tree: water was poured into the conductor of the cable and kept the cable was immersed in water while applying alternating voltage 15 kV at 50 Hz between the conductor and the water electrode, at  $90^\circ \text{C}$  for 18 months. The insulator was then spiral-cut, boiled in an aqueous Methylene Blue solution, and the interfaces between the insulator and the internal semiconductor layer and between the insulator and the external semiconductor layer were subjected to microscopic observation to investigate whether water trees were formed or not.

Volume resistivity: measurements following the AEIC-CS5-82 was performed on the outside semiconductive layer.

Table 1

		Extrusion workability	particles (piece/200 cm <sup>2</sup> )	Water tree	Volume resistivity ( $\Omega \cdot \text{cm}$ )
Examples of the Invention	1	good	2	nil	$6 \times 10^1$
	2	good	2	nil	$9 \times 10^1$
	3	good	2	nil	$3 \times 10^2$
	4	good	1	nil	$4 \times 10^2$
	5	good	3	nil	$9 \times 10^2$
	6	good	2	nil	$8 \times 10^1$
	7	good	2	nil	$4 \times 10^2$
	8	good	2	nil	$7 \times 10^1$
	9	good	4	nil	$1 \times 10^2$
	10	good	5	nil	$5 \times 10^2$
	11	good	7	nil	$1 \times 10^3$
	12	good	7	nil	$5 \times 10^3$
	13	good	6	nil	$3 \times 10^3$
Comparative Examples	1	good	25	Observed	$2 \times 10^1$
	2	unextrudable	2	Unmeasurable	Unmeasurable
	3	unextrudable	4	Unmeasurable	Unmeasurable
	4	good	22	Observed	$8 \times 10^1$
	5	good	21	Observed	$9 \times 10^1$
	6	unextrudable	5	Unmeasurable	Unmeasurable
	7	unextrudable	3	Unmeasurable	Unmeasurable
	8	good	21	Observed	$10^6 <$

Samples 1 to 13 of the present invention were readily manufactured by the common extrusion, showed extremely low tendency to form grains, were completely free from water trees, and had low volume resistivity.

Comparative Example 1 using only ethylene-vinyl acetate copolymer as the base polymer formed a large amount of grains and water trees. Comparative Example 2 was the case where ethylene-vinyl acetate copolymer and ethylene-propylene rubber were used as the base polymer. In this case, the viscosity was too high that the common extrusion was impossible. Comparative Examples 3 to 7 are the cases where waxy substances beyond the scope of the present invention were used. Therefore, the common extrusion was impossible in some cases, and grains and water trees were formed in other cases. In Comparative Example 8 the amount of carbon-black was below the specified value, and the volume resistivity was too high for a semiconductive layer.

While the invention has been described in detail and with reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing from the spirit and scope thereof.

## Claims

1. A semiconductive resin composition comprising 100 parts by weight of a polymer component comprising an ethylene-based copolymer, an ethylene-propylene rubber, and a low molecular weight polyethylene having an average molecular weight of 1,000 to 4,000, and 40 parts by weight or more of electroconductive carbon black.
2. A semiconductive resin composition as in claim 1, wherein the polymer component comprises 40 to 90 wt% ethylene-based copolymer, 30 to 5 wt% ethylene-propylene rubber, and 30 to 5 wt% low molecular weight polyethylene having an average molecular weight of 1,000 to 4,000.
3. A semiconductive resin composition as in claim 1, wherein the ethylene-based copolymer is an ethylene-vinyl acetate copolymer.
4. A semiconductive resin composition as in claim 1, wherein the ethylene-based copolymer is an ethylene-ethyl acrylate copolymer.
5. A semiconductive resin composition as in claim 1, wherein the conductive carbon black is at least one member selected from furnace carbon black and acetylene black.
6. A semiconductive resin composition as in claim 5, wherein the furnace carbon black has an arithmetic mean particle size of 25 to 40 m $\mu$ , iodine adsorption of 40 to 60 mg/g, and DBP oil absorption (measured by JIS A method) of 120 to 150 ml/100 g.
7. A semiconductive resin composition as in claim 1, wherein the composition further comprises an antioxidant.
8. A semiconductive resin composition as in claim 7, wherein the antioxidant is 4,4'-thio-bis(3-methyl-6-tert-butylphenol).
9. A semiconductive resin composition as in claim 1, wherein the composition further comprises a crosslinking agent.
10. A semiconductive resin composition as in claim 9, wherein the crosslinking agent is 1,3-bis(tert-butylperoxyisopropyl)benzene.

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**TITLE:** Ethylene copolymer blends contg.  
electroconductive carbon black,  
EPR incorporate low mol. wt.  
polyethylene to facilitate co-  
extrusion with insulation layers  
in high voltage power cable mfr.

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CA 1307366 C	September 8, 1992	EN
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EP 334993A3	N/A	1988EP- 115904	September 27, 1988
EP 334993B1	N/A	1988EP- 115904	September 27, 1988
US 4909960A	Based on	1988US- 249532	September 27, 1988

**INT-CL-CURRENT:**

<b>TYPE</b>	<b>IPC DATE</b>
CIPP	C08L23/04 20060101
CIPS	C08K3/04 20060101
CIPS	C08L23/08 20060101
CIPS	C08L23/16 20060101
CIPS	H01B1/24 20060101

**ABSTRACTED-PUB-NO:** EP 334993 A

**BASIC-ABSTRACT:**

Semi-conductive compsns. comprise 100 pts. wt. ethylene polymer (I), and at least 40 pts. wt. electroconductive carbon black (II). (I) consists of (a) an ethylene copolymer, (b) an ethylene-propylene rubber, and (c) polyethylene with average mol. wt. 1,000-4,000; pref. wt.% ratios (a):(b):(c) are 40-90:30-5:30-5. Opt. present is antioxidant (III), and crosslinking agent (IV).

Pref. (Ia) is an ethylene/vinyl acetate copolymer or an ethylene/ethyl acrylate copolymer. (Ib) is an ethylene/propylene copolymer, or an ethylene/propylene/unconjugated diene terpolymer. (Ic) has softening pt. 100-130 deg. C. (II) is a conventional furnace carbon black, or acetylene black.

USE/ADVANTAGE - The compsns. are useful for forming internal or external semiconductive layers of high voltage power cables having opt. crosslinked polyethylene as insulator. Due to incorporation of (Ic) the compsns. have excellent processability by extrusion and enable coextrusion of semi-conductive and insulating layers. The compsns. provide good water tree resistance in the cables, good dispersion of (II) particles being maintained.

**TITLE-TERMS:** ETHYLENE COPOLYMER BLEND CONTAIN  
ELECTROCONDUCTING CARBON BLACK  
EPR INCORPORATE LOW MOLECULAR  
WEIGHT POLYETHYLENE FACILITATE  
CO EXTRUDE INSULATE LAYER HIGH  
VOLTAGE POWER CABLE MANUFACTURE

**ADDL-INDEXING-TERMS:** ETHYLENE PROPYLENE RUBBER

**DERWENT-CLASS:** A17 A85 E14 E36 L03 X12

**CPI-CODES:** A04-G01E; A07-A02; A08-M09A; A08-  
R03; A09-A03; A12-E02A; E31-N04D;  
L03-A01B1; L03-A02B; L03-A02E;  
L04-A04;

**EPI-CODES:** X12-D01X; X12-D03B; X12-D03X;

**CHEMICAL-CODES:** Chemical Indexing M3 \*01\*  
Fragmentation Code C106 C810 M411  
M781 Q130 Q454 Q610 Specific  
Compounds R05085 Registry Numbers  
129798 131652 131663 2211 63 7 80  
9

**UNLINKED-DERWENT-REGISTRY- ; 0476U ; 0646U ;**  
**NUMBERS: 1669U ; 5049U ; 5085U**

**POLYMER-MULTIPUNCH-CODES-AND-KEY-SERIALS:**

**Key Serials:** 0009 0218 0221 0226 0239 0241  
0242 0246 0250 0251 0495 0544  
0789 1180 1201 2020 2198 2217  
2253 2262 2266 2285 2293 2319  
2333 2437 2438 2493 2551 2552  
2560 2562 2585 2599 2654 2667  
2726 2727 3020 3151 3153 3154  
3155 3158 3234



**Multipunch Codes:**

02&	032	034	040	041	046	047	048
050	066	067	220	222	231	247	266
267	27&	307	308	310	329	335	341
342	359	392	394	395	415	431	437
443	444	450	473	477	506	509	510
512	514	541	546	57&	575	58&	583
589	596	604	608	688	725	02&	032
034	040	041	046	047	048	050	066
067	134	174	220	222	231	247	266
267	27&	28&	307	308	310	329	335
341	342	359	392	394	395	415	431
437	443	444	450	473	477	506	509
510	512	514	541	546	57&	575	583
589	596	604	608	688	723	725	02&
032	034	040	041	046	047	048	050
074	076	081	083	220	222	231	247
266	267	27&	307	308	310	329	335
341	342	359	392	394	395	415	431
437	443	444	450	473	477	506	509
510	512	514	541	546	57&	575	58&
583	589	596	604	608	688	725	02&
032	034	040	041	046	047	048	050
074	076	081	083	134	174	220	222
231	247	266	267	27&	28&	307	308
310	329	335	341	342	359	392	394
395	415	431	437	443	444	450	473
477	506	509	510	512	514	541	546
57&	575	583	589	596	604	608	688
723	725						

**SECONDARY-ACC-NO:****CPI Secondary Accession Numbers:** 1989-126803**Non-CPI Secondary Accession Numbers:** 1989-218782